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ELEMENTS OF A COGNITIVE THEORY OF THE FIRM

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Elements of a cognitive theory of the firm

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Abstract

This paper presents elements of a cognitive theory of the firm, from the perspective of embodied cognition. It entails the notion of ‘cognitive distance’ between people that have developed their cognition in different environments. This yields the notion of the firm as a ‘focusing device’, to reduce cognitive distance for the sake of efficient collaboration and for the resolution of conflict. This focus yields organisational myopia, which needs to be compensated by outside relations, between firms, at some cognitive distance. Next, on the basis of principles derived from cognitive science, this paper tries to resolve the problem of combining structural stability and change, which in economics is known as the problem of combining exploitation and exploration. This provides the basis for a theory of learning and innovation in organisations and economies. The theory is elaborated on the basis of the notion of ‘scripts’, also derived from cognitive science.

Key words: organizational learning, theory of the firm

JEL classification: D21, D83, M13

Introduction

In this paper I employ the perspective of embodied cognition to develop a ‘cognitive’ theory of the firm and organisations more in general. An organisation is any form of coordinated behavior, while a firm is a special form of organisation, with a legal identity concerning property rights, liability and employment. A possible misunderstanding of terminology should be eliminated from the start. In this paper, the terms ‘knowledge’ and ‘cognition’ have a wide meaning, going beyond rational calculation. They denote a broad range of mental activity, including proprioception, perception, sense making, categorisation, inference, value judgments, and emotions. Following others, and in line with the perspective of embodied cognition, I see cognition and emotion (such as fear, suspicion), and body and mind, as closely linked (Merleau-Ponty 1942, 1964, Simon 1983, Damasio 1995, 2003, Nussbaum 2001).

The perspective of embodied realism provides the basis for a constructivist, interactionist theory of knowledge that does not necessarily wind up in radical post-modern relativism. According to the latter, the social ‘constructionist’ notion of knowledge entails that since knowledge is constructed rather than objectively given, any knowledge is a matter of opinion, and any opinion is as good as any other. This would lead to a breakdown of critical debate. Embodied realism saves us from such radical relativism in two ways. First, our cognitive construction builds on bodily functions developed in a shared evolution, and possibly also on psychological mechanisms inherited from evolution, as argued in evolutionary psychology (Barkow et. al. 1992). Second, by assumption we share the physical and social world on the basis of which we conduct cognitive construction. That constitutes a reality that is embodied (Lakoff & Johnson 1999). As a result of shared psychological mechanisms of cognitive construction and a shared world from which such construction takes place, there is a basic structural similarity of cognition between people. This provides a basis for debate. Indeed, precisely because one cannot ‘climb down from one’s mind’ to assess whether one’s knowledge is properly ‘hooked on to the world’, the variety of perception and understanding offered by other people is the only source one has for correcting one’s errors.

The basic assumption, or working hypothesis, of this paper is that the perspective of embodied cognition can usefully be applied for the development of a 'cognitive theory of the firm'. Such theory contains a number of elements that cannot all be discussed in this paper. Here, the following elements are discussed. First, I discuss the conceptual roots of embodied cognition, in philosophy, cognitive science, theory of meaning, and sociology. Embodied cognition yields a principle of 'methodological interactionism', to replace both the methodological individualism of economics, which yields under-socialisation, and the methodological collectivism of (some) sociology, which yields over-socialisation. Thereby, it offers a philosophical basis for integrating economics and sociology. Second, I analyze the implications of embodied cognition for the nature, purpose and boundaries of the firm. This yields the notion of the firm as a 'focusing device', which has implications for inter-firm relationships, such as alliances and networks. Third, I summarise a theory of organisational learning and innovation. It is aimed at solving the problem of combining structural stability and change, known in economics as the problem of combining exploitation and exploration (March 1991). The core of this theory is a 'heuristic', or set of principles, in a 'cycle of discovery' that was inspired by a view of the development of intelligence in children proposed by Jean Piaget. Finally, this paper elaborates that theory with the aid of the notion of scripts, which is also taken from cognitive science. These elements were developed in earlier work (Nooteboom 1992, 1999, 2000, 2003), but the aim of this paper is to spell out in more detail how they are informed by embodied cognition.

The development of a cognitive theory of the firm is needed for both theoretical and practical purposes. In economics and business, there is much talk of, on the one hand, the 'knowledge economy' and the 'learning organisation', and, on the other hand, the 'network economy' and the importance of inter-firm relations and networks for innovation. Until recently, there was lack of an adequate theory of knowledge to analyze and connect issues of innovation, learning and inter-firm relationships. Since according to embodied cognition knowledge is embedded in relations in the world, and is embodied on the basis of them, it has a natural application in learning by interaction in network economies.

A view of the economy that is close in cognitive perspective to that of embodied cognition, derives from Hayek (1999), whose views are discussed extensively elsewhere in this volume. However, while the central views of Hayek cohere with the argument of this paper, Hayek did not offer a theory of the firm.

I propose that there are two very different types of application of embodied cognition to a theory of the firm. First, I will show that there are *direct implications* for how an organisation enables people to function, in collaboration, communication, mutual perception, attribution of competencies and intentions, and conflict resolution. The second application of embodied cognition is more speculative, in an analysis by *analogy*. I propose, as a working hypothesis, that insights in the functioning of the brain (Damasio 1995, Edelman 1987, 1992, Lakoff & Johnson 1999) entail a fundamental 'logic', or set of heuristics, or principles, of cognitive structuration, which apply more generally, including processes of learning and innovation in organisations and economies (Nooteboom 2000). Perhaps, while economics can learn from cognitive science, there may also be conceptual traffic in the reverse direction. Perhaps insights in network phenomena in economics, embryonic as they are, can yield hints, or at least interesting questions, for studies in cognitive science. Of course, such analysis by analogy is hazardous. I certainly do not propose to look at people in organisations as if they are similar to neurons in the brain. The analogy I seek is the following. Organisations are confronted with the problem of how to combine on the one hand structural stability, for the sake of efficient operational functioning, in using existing resources and competencies, to survive in the short term, in 'exploitation', and on the other hand structural change, for learning and the development of new competencies, to survive in the longer term, in 'exploration' (March 1991). How does one combine structural stability with structural change? A similar problem, for sure, arises in the brain (Holland 1975, who first came up with the problem of exploitation and exploration), and in economics we might learn from how this problem of structuration is dealt with in cognitive science.

A related problem, or so I propose, arises in the 'structure-agency' problem in sociology. In economic systems, on the level of organisations and on the higher level of economic systems, institutional arrangements (organisations) and institutional environments enable and constrain the activities that fall within their compass, but those activities feed back to reconstruct those institutions. This is the problem of 'structuration' in sociology (Giddens 1984, Archer 1995). Sociology is relevant

in economic analysis from the perspective of embodied cognition, because it is geared to look at conduct as embedded in social structures in a way that economics is not.

Perhaps the research program undertaken here is overly ambitious, pretentious even, but it does seem to me that a perspective arises for coherence between fundamental concepts of structural dynamics in cognitive science, economics and sociology. I will try to argue this in a discussion of a number of intellectual ‘roots’ of embodied/embedded cognition.

Embodied and embedded cognition: the roots

A key characteristic of embodied cognition is that it sees cognition as rooted in brain and body, which are in turn embedded in their external environment. This simple characterisation already suggests that embodied cognition might help to yield more depth of insight in the view, which prevails in contemporary literatures of economics, business, and organisation, that firms learn and innovate primarily from interaction between them, in alliances, networks, and the like. This yields (at least) two levels of embedding: of individual minds in organisations, and of organisations in networks of organisations.

An issue, in the literature on organisational learning, is what learning on the level of an organisation could mean, in comparison with, and in relation to, learning on the level of individuals (Cook & Yanow 1996). Can we learn, here, from insights in the operation (emergence and functioning) of neuronal groups, in the brain, and interaction between them, by selection and mutual influence (Edelman 1987), in the structuration of ‘higher level’ phenomena of cognition (Nooteboom 1997)?

The notion that cognition is *embodied* is prominent in the recent work of cognitive scientists (Damasio 1995, 2003, Edelman 1987, 1992, Lakoff & Johnson 1999). In economics, it goes back to the work of Hayek (1999). In philosophy, it goes back to Merleau-Ponty (1964), who also argued that ‘the light of reason is rooted in the darkness of the body’. Another intellectual root is to be found, in my view, in Quine’s notion of cognition (in the wide sense, indicated above) as a ‘seamless web’ (Quine & Ullian 1970). A similar idea was offered by Bachelard (1940). This is very important, in my view, in its substitution of a theory of truth as ‘coherence’, within that seamless web of belief, for a theory of (a mysterious, magical) ‘correspondence’ between units of cognition and elements of an objective reality.

Interesting, in this seamless web notion, is the perspective for escaping from perennial problems of infinite regress in the justification of parts of knowledge on the basis of some other ‘higher level’, foundational parts, which in turn, then, must rest on yet higher levels of foundation. Here, Neurath’s metaphor comes to mind, of the mariner who reconstructs his boat, plank by plank, while staying afloat in it. To mend one plank one stands on another, which may in turn be mended from standing on the mended first one. In other words, some parts of cognition may provide the basis for adapting other parts, which in turn may provide the platform for adapting the first parts. This is how we bootstrap ourselves into learning without standing on any prior foundation.

The notion that cognition is *embedded*, and arises from interaction with the environment, goes back to Vygotsky (1962) and Piaget (197, 1974), with their idea that ‘intelligence is internalised action’.¹ In the literature on business and organisations, this is known as the ‘activity theory’ of knowledge (Blackler 1995), inspired also by the work of Kolb (1984). Another intellectual root lies in Wittgenstein’s idea of ‘meaning as use’, which is linked to the American pragmatic philosophers

¹ I am aware of the criticism of Piaget’s views and methodology of research (cf. Flavell 1967). However, I still think that some of his basic intuitions and ideas are valid. Apart from methodological criticism of Piaget’s work, a substantive point of criticism is that Piaget’s view is under-socialised. Here, there was an interesting difference of interpretation between Piaget and Vygotsky. In language acquisition by children, a phenomenon on which Piaget and Vygotsky agreed was that at some point children engage in ego-centric speech, oriented towards the self rather than social others, and that this subsequently declines. Piaget interpreted this as an outward movement from the self to the social other; a ‘decentration’ from the self. Vygotsky ascribed it to a continued movement into the self, in an ongoing process of formation and identification of the self and development of independent thought. The reason that egocentric speech declines is that overt speech is partly replaced by ‘inner speech’. I think Vygotsky’s interpretation is the correct one.

James, Dewey and Peirce. Cognitive categories are not to be seen as carriers of truth (in the usual correspondence sense), but as instruments that are more or less adequate for situated action. In sociology, the idea that cognition arises from interaction of people with their (especially social) environment arises, in particular, in the 'symbolic interactionism' proposed by G.H. Mead (1934, 1984). In the organisation literature, this has been introduced, in particular, by Weick (1979, 1995), who reconstructed organisation as a 'sense-making system'.

We need to consider issues of meaning in some depth. Here, I employ the basic terminology introduced by Frege (1892, Geach & Black 1977, Thiel 1965), with the distinction between sense ('Sinn', connotation, intension) and reference ('Bedeutung', denotation, extension). Frege characterised sense as 'Die Art des Gegebenseins', i.e. 'the way in which something (reference) is given'. I interpret this, correctly I hope, as sense providing the basis to determine reference. A famous example is Venus being identified as 'the morning star' and 'the evening star', depending on where you see it. Here, logically incompatible senses turn out to have the same reference.

Here, I propose a second link with Quine (1959), in his notion of the 'indeterminacy' of reference, or even its 'inscrutability', when as an anthropologist we enter into communication with a foreign tribe. An important feature of embeddedness is that the reference of terms is generally indeterminate without their embedding in a specific action context, *in combination with* the embodied web of largely tacit belief. At the conference on embodied cognition in Great Barrington, in 2003, which led to the present volume, professor Searle used the example of 'eating a hamburger'. Unspecified, but obvious, is the condition that the hamburger enters the body not by the ear but by the mouth. It is obvious by virtue of the 'background'. I suggest that the background consists of the *cognitive* background, in a seamless web of cognition, of the observer, *and* the context, of words in a sentence, in a context of *action*. The latter triggers associations between connotations embodied and distributed in the former. In this way, embedding is needed to disambiguate expressions that by themselves are underdetermined in their reference. Reference becomes not just indeterminate but inscrutable in communication with a foreign tribe, because the seamless web of cognition is woven differently, in its evolution in more or less isolated practical and cultural settings.²

A second effect of embeddedness, I propose, is that any event of interpretation, in a context of action, shifts meanings. In sum, we grasp our actions in the world to both disambiguate and construct meaning. How do meanings of words change in their use? Let us take the meaning of an expression as 'sense', in the Fregean sense, in a constellation of connotations connected across terms, which establishes reference. Neural structures provide the basis for categorisation, i.e. assigning a perceived object to a semantic class, on the basis of patterns of connotations that distinguish one category from another. This connects with de Saussure's (1979) notion that 'a word means what others do not'. It seems, however, that the activity of categorisation brings in novel connotations, or patterns of them, from specific contexts of action, and affects the distribution of connotations across categories. Then, an expression (sentence, term, sign) never has the exact same meaning across different contexts of action. Furthermore, I propose that any such act of interpretation shifts the basis for it. Associations between terms, on the basis of shared or linked connotations, shift the distribution of those connotations across terms. In neurophysiological terms, I suppose, this is embodied in selection and strengthening and weakening of connections between neuronal groups, as described by professor Edelman. Could this be indicative of how structures in their mutual influence can function efficiently while changing in the process?

The construction of meaning from actions in the world connects with the use of metaphors, as discussed by Lakoff and Johnson (1980), and as presented at the Barrington conference by professor Johnson. We grasp our actions in the physical world, in which we have learned to survive, to construct meanings of abstract categories, starting with 'primary metaphors' that build on proprioception. Thus, for example, good is 'up', because we stand up when alive and well, while we are prostrate when ill or dead. The analysis is important not only in showing how we cope in the world, but also in showing how metaphors can yield what Bachelard (1980) called 'epistemological obstacles'. I suspect that the primary metaphors, informed by experience with objects in the world, yield a misleading conceptualisation of meanings, for example, as objects. Since objects retain their identity when shifted

² See Quine's (1959) famous discussion of the meaning of 'gavagai'. It has to do with rabbits. But is it a rabbit-part, a feature that rabbits share with other entities, an aspect of rabbit behavior across time, or what?

in space, we find it difficult not to think of words retaining their meaning when shifted from sentence to sentence. Underlying this is the 'museum metaphor' of meaning: words are labels of exhibits that constitute their meaning, and the 'pipeline metaphor of communication': with words meanings are shipped across a 'communication channel'. Meanings and communication are not like that, but we find it difficult to conceptualise them differently. In short, in abstract thought, we suffer from an 'object bias'

If interpretation (categorisation) occurs by association on the basis of connected connotations that are distributed across terms, and if at the same time it affects the distribution of connotations, thus shifting meanings, analytical ambitions of past thought become problematic. Not only does the meaning of words depend on those of other words (Saussure), the use of words shifts what other words mean. Can we still separate the intersubjective order of language (Saussure: 'langue') and its individual, creative, practical use (Saussure: 'parole')? Can we separate semantics from pragmatics? Is this, perhaps, a case of structure and agency, where the agency of parole is based on the structure of langue but also shifts it? Is it a case of exploitation that yields exploration? For sure, we cannot maintain Frege's claim that the meaning of a sentence is a grammatical function of given (fixed) meanings of the words in it. What I have been saying is that the sentence also affects the meanings of words in it. Rather than analytical composition we have a hermeneutic circle (Gadamer 1977), where established meanings provide categorisation, which in turn affect established meanings (see Nooteboom 2000 for an elaboration and a discussion of a theory of poetics). In this context, consider the switch in Wittgenstein's thinking, from analyticity (in his 'Tractatus') to language as an inexplicable, irreducible 'form of life' (Wittgenstein 1976). What more can be said about words as 'forms of life', about how parole reconstructs langue? Saussure noted the role of parole, but focused his analysis on the order of langue.

The pressing question is by what principles the structuration of cognition, categorisation and meaning proceeds. We are back at the question of structure and agency, of stability and change, and of exploitation and exploration. How does the use of words change their meaning while maintaining stability of meaning for interpretation and meaningful discourse? Are there 'levels' of change, with 'minor change' that leads on, somehow, to 'large' or wider 'structural' change? How would that work? What happens in the brain in doing that? Is there a lesson for organisational learning? I will discuss this central problem later. First, I consider the direct implications of embodied cognition for the functioning of a firm.

Organisation as a focusing device

For my present purpose, to build a cognitive theory of organisation, what I make of embodied cognition is the following. For knowledge I take a social constructivist, interactionist view. People perceive, interpret and evaluate the world according to mental categories (or frames or mental models) that they have developed in interaction with their social and physical environment, in 'embodied realism' (Lakoff & Johnson 1999), with the adaptive, selectionist construction of neural nets (Edelman 1987, 1992).

Since the construction of cognition takes place on the basis of interaction with the physical and social environment, which varies between people, 'different minds think different things', as was recognised by Austrian economists (Lachmann 1978). This connects, in particular, with Hayek's view of localised, distributed knowledge, and his view of inter-firm relations (competition) as constituting a 'discovery process'.

The physical environment varies less than the social. However, the latter is often cognitively constructed on the basis of 'primary' physical metaphors (Lakoff & Johnson 1980), so that some of the similarity of the physical environment gets transferred to the cognitive construction of cultural categories. However, this 'second order' cognitive construction allows for more variety, as shown in the variety of metaphors 'people live by'.

As a result of differences in physical and cultural environments that are embodied in cognition, perception, interpretation and evaluation are path-dependent and idiosyncratic to a greater or lesser extent. By path-dependent I refer, here, to the condition that cognition takes place on the basis of categories that have developed in interaction with a certain context of action, so that the latter predisposes cognition. Cognition depends, literally, on the path of cognitive development. Different

people see the world differently to the extent that they have developed in different social and physical surroundings and have not interacted with each other. In other words, past experience determines 'absorptive capacity' (Cohen & Levinthal 1990). This yields what I call 'cognitive distance' (Nooteboom 1992, 1999).

An implication of this view for the theory of the firm is that in order to achieve a specific joint goal the categories of thought (of perception, interpretation and value judgment), of the people involved must be aligned to some extent (Nooteboom 1992, 2000). Cognitive distance must be limited, to a greater or lesser extent. This yields the notion of the firm as a 'focusing device', to reduce cognitive distance, to achieve a sufficient alignment of mental categories, to understand each other, utilise complementary capabilities and achieve a common goal. To achieve this, organisations develop their own specialised semiotic systems, in language, symbols, metaphors, myths, and rituals. This is what we call organisational culture. This differs between organisations to the extent that they have accumulated different experiences, in different industries, technologies and markets.

This idea of a firm is not new. It connects with the idea, in the organisation literature, that the crux of an organisation is to serve as a 'sensemaking system' (Weick 1979, 1995), a 'system of shared meaning' (Smircich 1983) or 'interpretation system' (Choo 1998). I propose that this yields a more fundamental reason for firms to exist than the reduction of transaction costs, although transaction costs are also part of the story (Nooteboom 1996, 2003). In a firm, people need to achieve a common purpose, and for this they need some more or less tacit shared ways of seeing and interpreting the world. Referring to the discussion in the previous section, they need a commonality of what at the conference in Great Barrington professor Searle called 'background'.

Present economic theories of organisation (and of law) tend to look at organisations (and law) as incentive systems. However, increasingly it is recognised that for a variety of reasons ex-ante incentive design is problematic. Due to uncertainty concerning contingencies of collaboration, and limited opportunities for monitoring, ex ante measures of governance are seldom complete, and need to be supplemented with ex-post adaptation. Such uncertainties proliferate under present conditions of professional work and rapid innovation. Professional work is hard to monitor and evaluate, and requires considerable autonomy for its execution. Rapid innovation increases uncertainty of contingencies and makes formal governance, especially governance by contract, difficult to specify. If such specification is nevertheless undertaken, it threatens to form a straightjacket that constrains the scope for innovation (Nooteboom 1999). Furthermore, the attempt to use contracts to constrain opportunism tends to evoke mistrust that is retaliated by mistrust, while in view of uncertainty there is a need to use trust rather than contract (Nooteboom 2002).

Organisational focus, provided by organisational culture, yields an epistemological and normative 'background' for ex-post adaptation, as a basis for coordination, mutual understanding, mutual adaptation, decision-making, and conflict resolution. Organisational culture incorporates fundamental views and intuitions regarding the relation between the firm and its environment ('locus of control': is the firm master or victim of its environment), attitude to risk, the nature of knowledge (objective or constructed), the nature of man (loyal or self-interested) and of relations between people (rivalrous or collaborative), which inform content and process of strategy, organisational structure, and styles of decision-making and coordination (Schein, 1985).

Note that the notion of organisational focus does not entail the need for people to agree on everything, or see everything the same way. Indeed, such lack of diversity would prevent both division of labor and innovation within the firm. As discussed in Nooteboom (1999) there is a trade-off between cognitive distance, needed for variety and novelty of cognition, and cognitive proximity, needed for mutual understanding and agreement. In fact, different people in a firm will to a greater or lesser extent introduce elements of novelty from their outside lives and experience, and this is a source of both error and innovation. Nevertheless, there are some things they have to agree on, and some views, often tacit, which they need to share, on goals, norms, values, standards, outputs, competencies and ways of doing things.

Organisational focus needs to be tight, in the sense of allowing for little ambiguity and variety of meanings and standards, if the productive system of a firm, for the sake of exploitation, is 'systemic', as opposed to 'stand-alone' (Langlois & Robertson, 1995). Exploitation is systemic when there is a complex division of labor, with many elements and a dense structure of relations between them, with tight constraints on their interfaces. An example is an oil refinery. In more stand-alone systems,

elements of the system are connected with few other elements, and connections are loose, allowing for some ambiguity and deviation from standards on interfaces. An example is a consultancy firm. An intermediate system, between systemic and stand-alone, is a modular system. Here, there are also multiple, connected elements, as in the systemic case, but the standards on interfaces allow for variety, where different modules can be plugged into the system.

Since cognition is a wide concept, with several aspects (perception, interpretation, evaluation), organisational focus can have a variety of contents, for which the focus may have different width, sharpness and tightness. Mintzberg (1983) distinguished five forms of coordination in organisations: Direct supervision, standardisation of processes, outputs or skills, and mutual adaptation. Later, he added coordination by values/norms, for 'missionary organisations' (such as the church). The focus can be directed at one or more of these forms of coordination. When processes are standardised, as in an assembly line, workers need to understand instructions, but may not need to be able to talk to each other. In professional organisations, where processes and outputs are difficult to standardise and monitor, one often resorts to standardisation of skills. When that is problematic, or insufficient, one may have to resort to mutual adjustment. Here, people need to share certain values and norms for doing that. In the development of economies that are more service oriented and more based on professional workers, there has been a shift towards coordination by standardisation of skills, mutual adaptation and 'missionary' goals, values and norms.

One aspect of entrepreneurship, which links with Schumpeter's (and Weber's) notion of the entrepreneur as a charismatic figure, is that it is his central task to achieve this: to align perceptions, understandings, goals and motives. Related to this, perhaps, Adam Smith also recognised 'authority' next to utility, in politics and organisation, to establish allegiance to joint goals, as discussed by Khalil (2002). In this context, I was struck by a comment, at the conference, by professor Edelman, that evolutionary selection can take place only in space constrained by values.

A puzzle is how a leader can contribute to coordination if this cannot be achieved by canonical rules that pretend to completely specify required conduct. One problem is how such a leader would know such rules, since the people he sets out to constrain and guide in their actions know better, in their interaction with customers, suppliers and technology, what could be done. A second problem, recognised in the business literature on 'communities of practice' (Brown & Duguid 1996, Lave & Wenger 1991, Wenger & Snyder 2000), is that such pre-specified rules cannot deal with the complexity and variability of situated action, in specific action contexts. This is in line with the argument, developed above, concerning the indeterminacy of reference and the context-dependence of meaning.

Here, I note the role of prototypes or 'exemplars' in language and categorisation (Rosch 1978, Nooteboom 2000). Since definitions can seldom offer necessary and sufficient conditions for categorisation, and meaning is context-dependent and open-ended, allowing for variation and change, we need prototypes. Prototypes are salient exemplars of a class that guide categorisation by assessing similarity to the prototype. This, I suggest, goes back to Aristotle's notion of 'mimesis'. The root meaning of a 'paradigm', in science is 'exemplar'. From this follows the role, in organisation, of leaders setting exemplars or prototypes of conduct, embodied in myths and stories of 'heroes' that do not specify conduct and yet guide it.

The process of focusing, in an organisation, is related, I suggest, to the decision heuristic, recognised in social psychology, of 'anchoring and adjustment' (Bazerman 1998). According to this heuristic, judgment is based on some initial or base value ('anchor') from previous experience or social comparison, plus incremental adjustment from that value. People have been shown to stay close even to random anchors that bear no systematic relation to the issue at hand. First impressions can influence the development of a relation for a long time. This is conducive to both coordination and myopia. An implication of the notion of a firm as a focusing device is that the need to achieve a focus entails a risk of myopia: relevant threats and opportunities to the firm are not perceived. To compensate for this people, and firms, need complementary sources of outside intelligence, to utilise 'external economy of cognitive scope' (Nooteboom 1992). This yields a new perspective on inter-organisational relationships, next to the usual considerations, known from the alliance literature, such as economies of scale and scope, risk spreading, complementarity of competence, flexibility, setting market standards, and speed and efficiency of market entry (Nooteboom 1999, 2003). This perspective is consonant with the notion of double embeddedness, indicated before, of minds in organisation, and organisations in

outside networks. It also fits well with the prevalent idea in the literature on innovation systems that innovation derives primarily from interaction between firms (Lundvall 1988). Here again the trade-off arises between cognitive distance, for the sake of novelty, and cognitive proximity, for the sake of understanding and coordination.

The notion of a firm as a focusing device yields an alternative to TCE, for an explanation of the boundaries of the firm. The present theory yields a prediction that is opposite to that of classical transaction cost economics: with increasing uncertainty, in terms of volatility of technology and markets, firms should not integrate activities more, as transaction cost theory predicts, but less, because the need to utilise outside complementary cognition is greater. Here, the prediction is that firms will engage less in mergers and acquisitions and more in intensive alliances at some cognitive distance, but with sufficient durability and intensity to achieve mutual understanding and cooperation. This prediction has been confirmed empirically by Colombo & Garrone (1998).

Cognitive distance

Diversity is a crucial condition for learning and innovation, to produce Schumpeterian ‘novel combinations’, as demonstrated in evolutionary economics (Nelson & Winter 1982). Diversity is associated with the number of agents (people, firms) with different knowledge and/or skills, who are involved in a process of learning or innovation by interaction. However, next to the number of agents involved, a second dimension of diversity is the degree to which their knowledge or skills are different. This takes us back to the notion of ‘cognitive distance’. Note that since cognition also includes emotion-laden value judgments, cognitive distance includes different normative perspectives on behavior.

On the basis of different experiences, with different technologies and different markets, and different organisational histories, in other words at some cognitive distance, outside firms perceive, interpret and understand phenomena differently, and this may compensate for organisational myopia. The different foci of firms entail cognitive distance between firms. In processes of learning and innovation, in interaction between firms, this yields both an opportunity and a problem. The opportunity lies in diversity: the novelty value of a relation increases with cognitive distance. However, mutual understanding decreases with cognitive distance. If effectiveness of learning by interaction is the mathematical product of novelty value and understandability, the result is an inverse-U shaped relation with cognitive distance. Optimal cognitive distance lies at the maximum of the curve. This is illustrated in Figure 1.

Figure 1 about here

In Figure 1, the downward sloping line represents understandability, on the basis of ‘absorptive capacity’ (Cohen & Levinthal 1990). The upward sloping line represents the novelty value of a relation. The optimal level of cognitive distance from a learning perspective lies in-between very low and very high levels of cognitive distance.

The figure implies a difference between reducing cognitive distance and crossing it, on the basis of absorptive capacity. The difference is the same as that between empathy and identification, recognised in social psychology and in the literature on the development of trust (McAllister 1995, Lewicki & Bunker 1996). Empathy entails that one has sufficient understanding of another’s language, and ways of thought, to understand him, without, however, ‘thinking the same’. Identification entails ‘thinking the same’ (while recognising that thoughts are never identical). As parties engage in prolonged interaction, particularly when that is exclusive, i.e. when there are no outside interactions in the relevant area of cognition, people will increasingly think alike, and cognitive distance is reduced, i.e. identification takes place.

Wuyts et. al. (2003) put the hypothesis of optimal cognitive distance to two empirical tests. The first test was conducted on a combination of the basic hypothesis of optimal cognitive distance with the second hypothesis that cognitive distance decreases with increased frequency and duration of interaction. This yields the hypothesis of an inverted U-shaped relation between radical technological

innovation and the extent to which firms ally with the same partners over time. That hypothesis was tested on data on vertical alliances between biotech and pharma companies, and was supported. The second test was conducted on a combination of the basic hypothesis of optimal cognitive distance with a second hypothesis that the likelihood of a collaborative alliance increases with the expected performance of collaborative innovation. This yielded the derived hypothesis that the likelihood of an alliance for innovation has an inverted U-shaped relation with cognitive distance. That hypothesis was tested on data on horizontal alliances in ICT industries. Cognitive distance was measured by differences in degrees of specialisation in different dimensions of technology, inferred from patent data. Partial support was found. Technology-related measures of cognitive distance were not found to have any significant effect, but several indicators of differences in firms' organisational characteristics proved to have the expected inverted U-shaped effect. Several considerations were offered to explain why organisational aspects turned out to be more important than technological ones in ICT industries. These tests are preliminary. For a more adequate test we need data that include both a measure of cognitive distance and a measure of radical innovative output. Here, the first test includes the latter but not the former, and the second test includes the former but not the latter. A search is going on for a data set that includes both.

Figure 1 certainly does not offer any 'final word' on cognitive distance, and harbors problems that require attention. While the proposed difference between crossing cognitive distance (empathy) and reducing it (identification) may have some face value, what, more precisely, is the difference between understanding someone and having the same thoughts? Furthermore, Figure 1 is misleading to the extent that it offers a static frame for what are essentially dynamic processes of interaction. As discussed before, while existing meanings form the basis for sense making and categorisation, in the process of categorisation they shift. In particular, absorptive capacity develops in the process of absorption. An attempt is made to visualise this, to some extent, in Figure 1, with shifts in absorptive capacity. For more codified knowledge, absorptive capacity may be raised by R&D, and for more tacit knowledge it may be raised by cumulative experience in communication with people who think differently. Figure 1 shows how an upward shift of the line representing absorptive capacity yields a higher optimal cognitive distance and a higher level of innovative performance. We are aiming for an empirical test that endogenises absorptive capacity, as a function of cumulative past R&D and experience with inter-firm collaboration

Exploitation and exploration

Now, I turn to the fundamental problem of how to combine stability and change of structure, and exploitation and exploration that was discussed before. How can one change structure (exploration) in the process of using it (exploitation)? How does this bootstrapping take place? A proposal for this was made in Nooteboom (2000). It was inspired by cognitive science, in particular the idea of Jean Piaget (1970, 1974, Flavell 1967), that people 'assimilate' perceptions into cognitive structures, and in the process 'accommodate' them. Piaget proposed that this occurs in several stages. At first, novel cognitive structures are ill defined, uncertain, and unstable, with frequent relapses ('d calages') into preceding forms of thought. Repetitive assimilation is needed for them to become more coherent, consistent and stable, in a process of consolidation. Next, there is a tendency towards generalisation, where established structures are applied, in migration, to novel contexts of application. Psychologists tell me that there is a well-known, instinctive drive of 'over-confidence' do to this, as exhibited, for example, in child's play. By such extraneous application, in a novel context, the practice encounters insufficiencies, which are bound to arise in contexts that were not part of the original development of the structure. These are first tackled by small, 'proximate' differentiations of existing structure. When that fails to work, this next leads to 'reciprocation' between different, parallel structures that are found to be somehow related, in the new context. Such novel combinations (note the association to Schumpeter's notion of innovation by novel combinations) yield inefficient hybrids that somehow lead on to novel structures in the form of novel 'architectures' (Henderson & Clark 1990) of old and new elements, derived from different, previously distinct structures. Note the connection, here, with the earlier discussion of how categorisation shifts categories.

This Piagetian process is interesting in that it is strongly reminiscent of the problem of exploitation and exploration, and it suggests how ongoing application, in exploitation, with adaptations that

proceed from proximate to distant change, can lead to novel structures (exploration). Could this process be used for our present purpose?

I propose that there is a link with the famous methodological debate between Popper, Kuhn, Lakatos and Feyerabend (the 'PKLF debate') (Popper 1973, 1976, Kuhn 1970, Lakatos 1970, 1978, Lakatos & Musgrave 1970, Feyerabend 1974). To recall: Kuhn claimed, descriptively, that scientists do not in fact adhere to Popper's principle of falsification, and, normatively, that they were right, because it is not rational to scrap any (cognitive) investment as soon as it turns out to be imperfect. One will scrap it only when cumulative failure becomes 'excessive'. From the perspective of organisation I add a related principle of motivation. It is difficult to get people to accept the uncertainty and effort of surrendering existing ways of doing things before the need is manifest and cumulative, in threats to the survival of the firm and its jobs.

The economic argument for conservatism can be deepened on the basis of the concept of systemic production systems, indicated before. If an organisation, or economic structure more generally, is highly systemic, i.e. there are many components that are densely connected and that have strong ties in the sense of tight constraints on their interfaces, then any small deviation in any component would soon have repercussions, with widespread needs for adaptation across the system. In other words, deviation would destroy the integrity of the system, and organisational focus has to be narrow and tight to protect it.

However, next to such an economic argument for a certain amount of theoretical conservatism, there is also an epistemological argument, which Popper, in fact, conceded in the course of the PKLF debate:

'I have always stressed the need for some dogmatism: the dogmatic scientist has an important role to play. If we give in to criticism too easily, we shall never find out where the real power of our theories lies' (Popper 1976: 52).

The principle here is that one needs to maintain existing structures to obtain a more or less coherent and consistent view of where its limitations lie. Without that, one would have no clue what to change and what to retain. To set out on change at the merest sign of imperfection would yield not only lack of stability for exploitation, but would also yield undirected, random, neurotic behavior (cf. Lounamaa & March 1987).

Next, I add a second epistemological principle. In order to change, one needs to perceive not only a need and locus of change (where current practice fails), but also hints as to what to incorporate from external experience in order to change it. That is where Piaget's principle of reciprocation comes in. By observing, in a new context of action, practices that appear to be successful, in that context, in areas where one's current practice seems to fail, one has a hunch of what novel elements or 'chunks'³ to introduce and try out.

To Piaget's principle of generalisation, i.e. a migration or shift of practice to novel contexts of application, as a postulated innate, instinctive drive, I add a principle of escape. As indicated before, one may need to escape to an outside niche, because one is, justly, not allowed to destroy the systemic integrity of established practice. Next to this economic argument for the protection of systemic structures, there are pressures of a social-psychological nature. After innovation has settled down into a 'dominant design', as identified in the innovation literature (Abernathy 1978, Abernathy & Utterback 1978, Abernathy & Clark 1985), there are strong pressures to conform to it. There are strong psychological pressures to be an insider in dominant groups, and social pressures to acquire legitimisation. DiMaggio & Powell (1983) argued that apart from effects of evolutionary selection of the most successful practice, there are pressures towards 'organisational isomorphism', by mimesis of established practice and conformance to norms, established by professional organisations, suppliers, customers, competitors, and regulatory agencies, in 'organisational field'. An example of such herd behavior, or bandwagon effect, is the drive to engage in mergers and acquisitions, in spite of the fact that it is well known that they fail more often than they succeed (Nooteboom 2003). From the

³ One reason to use the term 'chunking' is that it is familiar in cognitive science. In the brain, the notion of reciprocation appears to be paralleled in the phenomenon that different, parallel neuronal groups may exchange 'chunks' between them.

perspective of the present paper, I would add that to the extent that the economic system is closed to new entry, and the pace of innovation subsides, ongoing interaction between firms yields reduced cognitive distance: firms start to think alike.

To escape from all these forces of conformism one may need to take refuge in an outside niche to gain freedom to be different. This, incidentally, is why many heterodox economists feel the need to escape to business schools that allow them to deviate from mainstream economics. The escape to outside niches often takes the form of experimentation with novelty in structures in which there is less threat to systemic integrity. This is consonant with the fact, in the history of technology, that initially innovations are developed not in areas where they could achieve their full potential, but in areas where they could be tolerated. The principle is also reflected in the phenomenon of 'spin-offs', where entrepreneurial types escape from the employer who constrains experimentation, to preserve the established order.

Interestingly, this idea of escape links with the notion of 'allopatric speciation' in evolutionary theory (Eldredge & Gould 1972). New species often arise outside, or at the periphery, of the parent niche. After a lengthy process of experimentation, a breakthrough, including invasion into the parent niche, can occur relatively fast, yielding 'punctuated equilibria'. The relative slowness of prior development, I propose, can be understood from the Piagetian stages of generalisation, differentiation and reciprocation. For application of the argument to economics this is interesting in view of the fact that punctuated equilibria have been regularly observed (but left unexplained) in the business literature (Tushman & Romanelli 1985, Tushman & Anderson 1986, Romanelli & Tushman 1994).

A puzzle remains. How does the hybridisation that results from reciprocation lead on to the 'radical' innovation of novel architectures of elements from different structures? For this I propose the following argument. Hybrids are inefficient and sometimes inconsistent. To maintain the integrity of existing structure, as much as possible, novel elements may have to be 'patched on' in different locations in the architecture, which yields duplication. This makes coordination complex (in a 'spaghetti' structure), and blocks concentration of activities to yield economies of scale. Above all, novel elements are constrained by existing structure in the realisation of their potential. The history of technology abounds with examples of this. An example is the shift from wood to iron in the construction of bridges (Mokyr 1990). Unlike wood, metal can be welded. At first, wedge shaped connections required for wood construction were retained while for metal they do not make functional sense, so that this 'chunk' in the practice of construction was later dropped.

This yields a crucial point. The fact that the potential of novel elements is identified but cannot be realised under the constraints of existing structure yields both a motive for more radical structural change, and a hint of how to do that, and thereby eliminate the encumbrances of hybridisation. This, then, yields pressure to experiment with a break-up of systemic structures that were protected before, and rightly so, to preserve systemic integrity. And that, I propose, explains punctuated equilibria. It is not until after a lengthy process of differentiation and reciprocation that wider systems are allowed to be affected. That, then, can occur with a speed that is high relative to the round-about path needed to prepare for the justification and acceptance of systemic break-up, in an 'invasion of the parent niche'. At this stage we are back at the beginning of the 'cycle of discovery', with the experimentation of novel architectures that also affect wider systems.

The account of generalisation suggested that it entails a voluntary escape from existing dominant practice, in an active strategy of expansion. However, the crux is a change in the context of application, and this may also arise in different ways. Often, existing firms are more passive, and are then confronted with the invasion of novelty. In other words, they do not actively seek a novel context of application, but are confronted by their familiar context of application being replaced by a new one. In fact, this contributes to the phenomenon of punctuated equilibrium. While novelty was explored 'outside' by more entrepreneurial firms, when it breaks through, other firms are forced to adapt, which accelerates the break-through. An example from recent research (Gilsing 2003) lies in the development of multi-media, carried by the development of the Internet. Publishers were not active in this. They did not actively explore opportunities to mix media that were technically enabled by digitalisation and commercially interesting as a result of the Internet. Entrepreneurs, often younger employees, within those companies who saw novel opportunities could not have their ideas accepted, and 'spun off' into independent entrepreneurial ventures. When the potential of Internet became clearer, publishers were forced to start going along, on the pain of losing out.

Among other things, application of the process of structural change to business systems yields an insight into the conduct of multinational corporations (MNC's). They are subjected to pressures towards expansion into novel markets. There is an economic motive: the home market has become saturated, with increasing diffusion of, and competition in, consolidated novelty, which reduces profit margins. They seek expansion to maintain growth and profit margins. However, I propose that there is more to it, and that there is an underlying instinctive drive towards generalisation, according to the principle of over-confidence. Entering new markets, MNC's are confronted by novel challenges, which may set the dynamic of learning in motion, as described above, even though their expansion was not driven by any explicit strategy of learning and innovation. Recently, however, some MNC's have caught on to the principle, and are now using internationalisation as a deliberate learning strategy.

All this can perhaps be summarised in the following metaphor. As in crime, in order to transgress boundaries of accepted practice, one needs opportunity, motive and means. Here the opportunity lies in the escape, in generalisation, to outside niches where transgression is feasible. Motive lies in the accumulation of failure encountered in novel contexts of application. Means lie in the discovery of locations and directions of change, and elements that are eligible for introduction into experimental hybrids, in order to adapt and survive in the novel context.

What I have tried to do, in this section, is to adopt principles from cognitive science, on the working hypothesis that it indicates fundamental principles of cognitive structuration on the basis of action (embedded embodying) that also apply to economics. Of course, there was a need to complement it with principles from economics and social science. My claim is that this works.

Scripts

In Nooteboom (2000) I tried to make the analysis more tangible by employing another notion from cognitive science. This is the notion of scripts, derived from the work of Abelson (1976), Shank (1980), Shank & Abelson (1977, 1995). A script is a structure of connections between nodes (or 'chunks') that constitute component activities. The paradigmatic example was a restaurant script. In a traditional restaurant script, with table service, people select their food (selection node or chunk) after they are seated (seating node), and they pay (payment node) after eating (eating node). Within constraints imposed by connections between nodes, a node allows for different forms of action. In the payment node, for example, the use of cash and checks was later supplemented by the use of bankcards and credit cards, and, more recently, chip cards, eliminating the use of checks.

Mental scripts yield mental economy. In our mental 'background' we have a wide assortment of scripts that share nodes, albeit with different contents. The context of practice triggers scripts, perhaps inappropriately. This triggering is efficient, in that we can attribute features (nodes and structure) very quickly, on the occasion of observing only one. Here, categorisation takes the form of trying to assimilate observations into nodes of scripts. The price we pay for this efficiency is prejudice: attribution may be highly inappropriate.

The notion of cognitive scripts has been criticised for being too stereotyped, rule based and rigid for most everyday contexts of life (Johnson-Laird 1983). As formulated by McClelland, Rumelhart and Hinton (1987: 9):

Scripts (and 'frames', 'schemata') are useful structures (for storing knowledge) 'but ... only approximations .. any theory .. will have to allow them to interact with each other to capture the generative capacity of human understanding in novel situations. Achieving such interactions has been one of the greatest difficulties associated with implementing models that really think generatively'.

Clearly this is crucial, in view of the role of reciprocation in the development process, discussed above. We must preserve slack, or ambiguity, because that provides the holes into which novelty can creep in and break a script open. Exploitation must allow for the variety that is needed for exploration. In the restaurant script, what happens if a dog enters? There is no prescribed behavior. But in some restaurants it will be allowed if the dog is accompanied and lies under the table. Some people may sneak food to it. In the US some restaurants provide 'doggy bags' to take home remaining scraps of food. Such eventualities are not provided for in the stereotyped script, but neither do they have to be taken as

excluded. The scripts that people have in their repertoires of action vary because their experiences vary. Shank and Abelson (1995) described this as follows:

‘Scripts serve as a kind of storehouse of old experiences of a certain type When something new happens to us in a restaurant that tells us more about restaurants, we must have some place to put that new information so that we will be wiser next time. ... My restaurant script won’t be exactly the same as yours, but they will both include information such as “one can expect forks to be available without asking, unless the restaurant is Chinese”.’

Perhaps we can interpret a script as a set of ‘default rules’: they cannot be specified in advance for all contingencies. They apply until challenged by failure, and then they may be complemented or modified. Novel situations may require the merging of different scripts. This can only be left to the discretion and skill of the people involved. Shank (1980) described the following case:

Suppose that in a restaurant you get a headache. Your usual script would be to walk to the medicine cabinet at home. Here, without hesitation, you ask the waitress for an aspirin, which was not foreseen in the restaurant script.

Perhaps actual practices should be seen not as single scripts but as collections of different variations upon a stereotype or prototype. Here, I recall the notion from Rosch (1978) that in view of the incompleteness of reference and the impossibility of closed definitions, categorisation occurs by the judgment of similarity to a prototype. Perhaps actual practices should be seen not as single scripts but as collections of different variations upon a script for different conditions (Holland et. al. 1989). Summing up: Although it is clear that a single, deterministic script does not suffice as a full model of competence, it can form an important building block.

In the present context, the notion of a script is useful for several reasons. First, it seems to have a straightforward application to organisations, as the example of the restaurant script already indicates. Second, it may help to grasp the multi-level problem of people in organisations, and organisations in their environments. In an organisational script, the nodes encompass ‘subscripts’ of action, as illustrated with the different modes of payment in the restaurant script. Components of those actions may entail yet lower level scripts. Organisational scripts may be seen as representing activities that are substituted into nodes of ‘superscripts’ of supply chains in industries. Third, scripts may illustrate different levels or degrees of innovation. In the restaurant script there is lower level, architecture preserving innovation within nodes, as illustrated by the introduction of chip cards in the payment node. An example of a higher-level, architectural innovation, is the innovation of a self-service restaurant. There, we have a different configuration of existing nodes: food selection and paying precede seating and eating. Of course, in this architectural re-arrangement, the component nodes will change: one selects food not from a menu but from a food display, and one carries the food oneself. This, in fact, illustrates a previous point that ‘chunks’ of meaning change when inserted in different structures. Another form of innovation is the introduction of outside nodes from parallel scripts, in reciprocation. One might, for example, introduce the showing of films during dinner (as has in fact been done). In fact, self-service restaurants arose by adopting principles from self-service retailing.

The main application of scripts, in the present context, is that they may yield a better grasp of the development process discussed before. We can see generalisation as the application of a script in a new context (a retail self-service script for restaurants), differentiation as architecture-preserving changes of activities within nodes, or as a re-configuration of existing nodes, reciprocation as the exchange of nodes between scripts, and radical innovation as the formation of a new script architecture of nodes from different prior scripts.

Scripts are models of processes in reality. They may be represented in documents, and they are in some way, often only partially, and to a smaller or larger extent tacitly represented in the mind. Observation will trigger already existing mental scripts, which are re-constructed in the formation of a novel mental script. Different people will reconstruct organisational processes differently. It is part of organisational focus to achieve more or less similar, or at least consistent, mental reconstructions of organisational scripts, or parts of them.

Conclusion

In this paper, I have attempted to achieve four things.

First, I argued that the perspective of embodied cognition yields a basis for connecting, if not integrating, fundamental ideas from cognitive science, epistemology and philosophy of language. It yields a principle of methodological interactionism that transcends the distinction between methodological individualism of economics and the methodological collectivism of (some) sociology, and thereby provides a perspective for integrating economics and sociology. People constitute their identity in interaction with others, but this yields individualised cognitive structures, along personal paths of development. As a result, there is 'cognitive distance' between people.

Second, I have shown the implications for a cognitive theory of the firm. The notion of cognitive distance leads to the notion of an organisation as a 'focusing device', and its implications for the 'boundaries of the firm' and for learning by interaction. This yields predictions that run counter to transaction cost economics, and that have been confirmed, at least in part, by empirical tests. The analysis connects the theory of the firm with a theory of network economies.

Third, I have used principles of cognitive structuration from cognitive science in an attempt to explain how organisations learn, and how innovation takes place, in economic systems. The claim is that there are basic principles to deal with the problem of combining stability and change of structure, which help to resolve what in economics is known as the problem of 'exploitation and exploration'. The analysis contributes to an explanation of observed 'punctuated equilibria' in economics, and to an understanding of processes of internationalisation.

Fourth, I have tried to further elaborate the theory in terms of 'scripts', as cognitive representations of organisational processes.

Clearly, the cognitive theory of the firm contains more than could be discussed in this paper. There are further implications for organisation and management, some of which are discussed in prior and recent work (Nooteboom 2000). There is much work to be done in the further elaboration of what goes on within and between organisations. There are important implications for the analysis of innovation and of innovation systems. There is further work in the use of embodied cognition for a deeper understanding of decision heuristics known from social psychology. In particular, embodied cognition has important implications for the process of trust building in organisations. Trust is a particularly interesting theme, because it entails all those features that are difficult to deal with from the perspective of mainstream (rational choice) economics, and belong to the core of embodied cognition: the intertwining of emotions and rationality, radical uncertainty (unpredictability) of motives and actions of people, context dependence of perception, categorisation and meaning, the 'default' nature of cognition, routinisation of conduct, and the adaptive value, combined with risks of error, of decision heuristics. Some of that analysis is conducted in previous work (Nooteboom 2002), but much remains to be done.

The analysis may also raise questions that are worthwhile for cognitive science. Can issues and phenomena discussed in this paper be explained, corrected, or complemented by research in that field?

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Figure 1.1: Optimal cognitive distance

